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(58) Field of search
H2A
Selected US specifications from IPC sub-class
H02K

(54) Brush shoe cross section for a cranked commutator

(57) A commutator device for electric motors has a commutator with a plurality of commutator segments (4) with which sliding contact is made by brush shoes (2) of brushes (1) formed of electrically conductive metallic strips and having a cross-section forming linear edges which make sliding contact with the commutator. Separating grooves (5) between the commutator segments (4) are formed into a crank shape so that the flow of current from a brush to the commutator is not interrupted. The cross-section is preferably V-shaped, with said linear edges defined either at the distal or the proximal ends of the legs of the V.

FIG. 1A

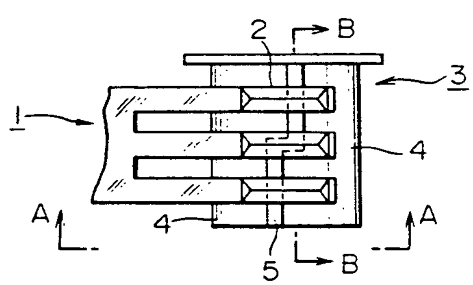

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FIG. 1A

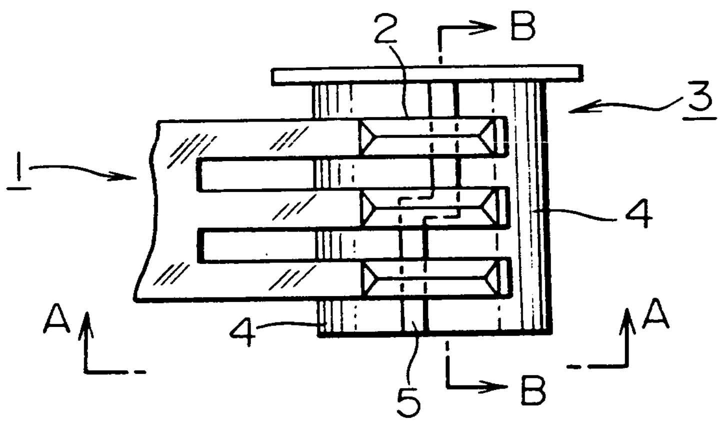


FIG. 1B

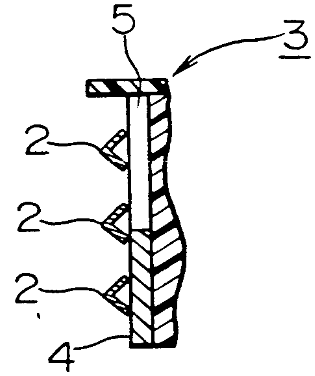


FIG. 1C

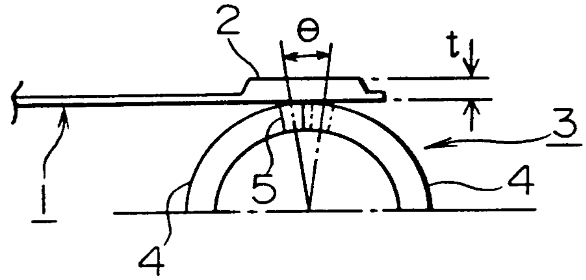


FIG. 2A

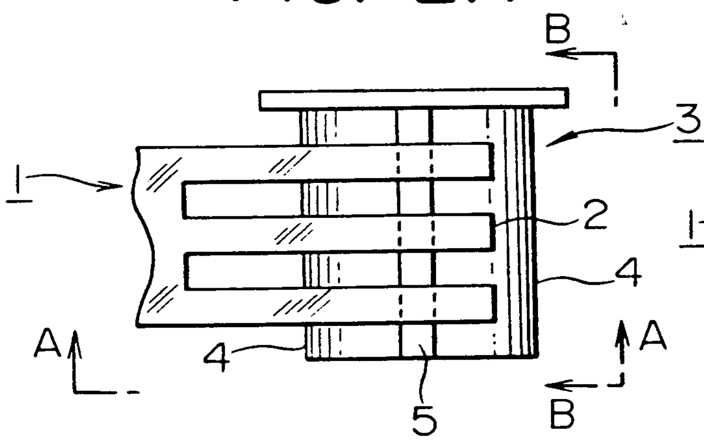


FIG. 2B

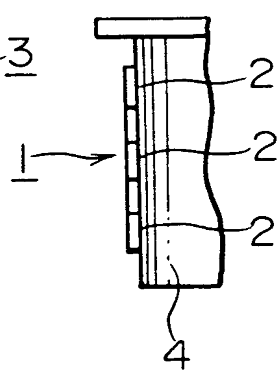


FIG. 2C

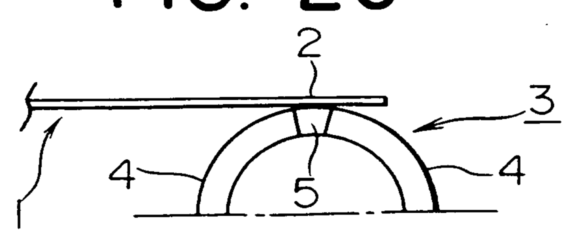


FIG. 5A

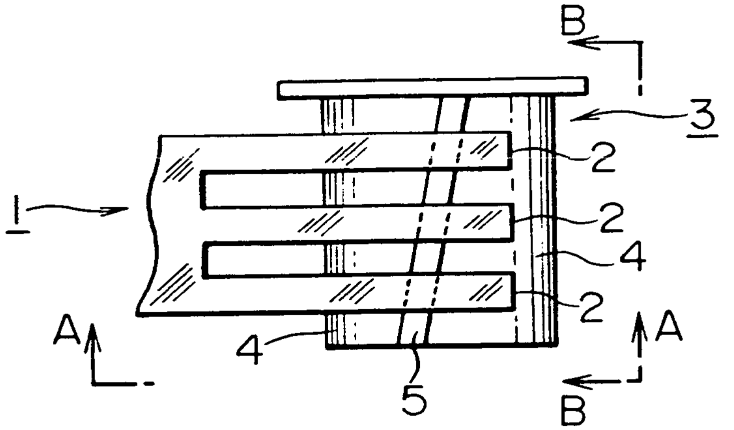


FIG. 5B

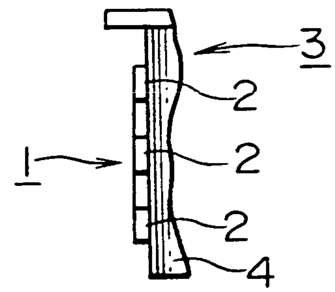


FIG. 5C

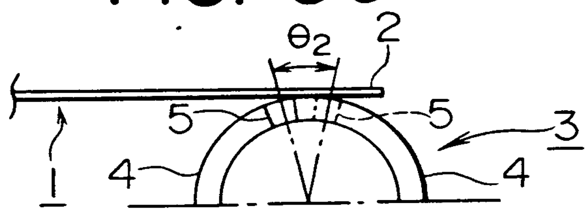


FIG. 6A

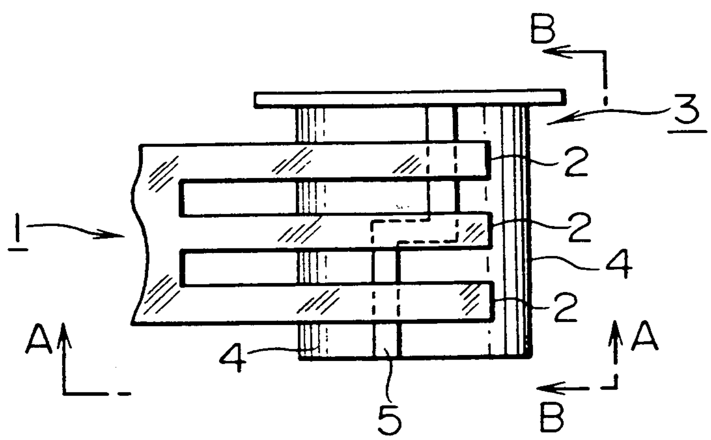


FIG. 6B

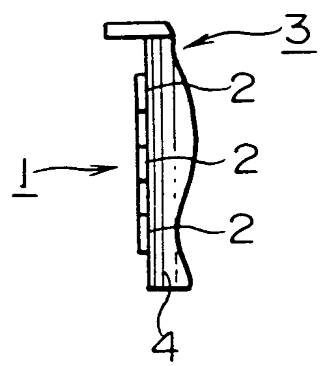
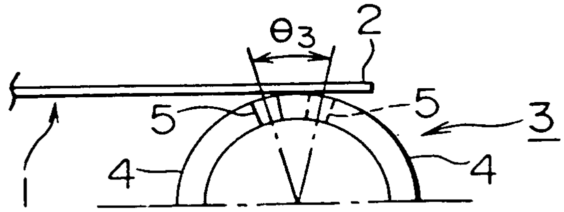


FIG. 6C



COMMUTATOR DEVICE FOR ELECTRIC MOTORS

This invention relates to commutator devices for electric motors. More particularly it relates to a commutator device for miniature motors adapted to maintain good sliding contact between a commutator comprising a plurality of commutator segments and brush shoes extending in planes substantially perpendicular to the commutator axis.

In known electric motors, particularly miniature motors, performance is largely dependant upon the stability and continuity of the supply of electric current to the windings of the motor rotor via the commutating device. The conventional form of commutator has a plurality of commutator segments which are successively in sliding contact with brushes connected to an electrical power source as the rotor rotates. As this contact moves from one segment to the next electrical noise and sparking will normally result, and this together with the sliding contact can cause the production of electrically resistive material on the commutator surface. To reduce these effects, alterations to the shape and orientation of the spaces between successive commutator segments have been proposed to improve the continuity of current flow. However, problems still remain, particularly in the production of electrically resistive material on the commutator surface.

The present invention addresses the above problems, and seeks to provide a mechanism by which obstructive build up of resistive material on the commutator surface

can be restricted while retaining substantial continuity in the flow of electrical current to the commutator. To this end, a commutator device according to the invention comprises a commutator and electrically conductive brushes for making sliding electrical contact therewith, the commutator having a plurality of commutator segments separated by crank shaped grooves, and each brush having at least one brush shoe extending in a plane substantially perpendicular to the commutator axis for tangential engagement with the commutator segments, at least a portion of a said at least one brush shoe having a cross-section shaped to define at least one linear edge extending along the shoe in said plane for engagement with the commutator. Normally, each brush has a plurality of elongate brush shoes extending from the body of the brush to define a plurality of linear edges substantially parallel to one another.

In preferred embodiments of the invention, the or each brush shoe has a V-shaped cross-section which is simple to press into a sheet metal brush for example, and may be oriented such that linear edges at the distal ends of the legs of its cross-section engage the commutator surface. Alternatively, the orientation of the or each shoe may be inverted; ie, such that the linear edge at the junction of the legs of its cross-section engages the commutator surface.

The design of commutator devices according to the invention is simple and easy to apply to the construction of electric motors, particularly miniature motors and

particularly in the mass production thereof. Its benefits include improved stability in the supply of electrical current to the commutator, and extended service life of the device.

The invention will now be described by way of example and with reference to the accompanying drawings which illustrate an embodiment of the invention and a number of previously proposed designs of commutator device. In the drawings:

Figure 1A is an external view of an embodiment of this invention;

Figure 1B a section taken along line B-B in Figure 1A;

Figure 1C a partial end view taken along line A-A in Figure 1A;

Figures 2A, 2B and 2C are views similar to those of Figure 1, but showing an example of a conventional type of commutator device for miniature motors;

Figure 3 shows the formation of blackened foul matter on a commutator of the type shown in Figure 2; and

Figure 4, 5 and 6 show views similar to those of Figure 2, but of other examples of conventional type commutator devices for miniature motors.

Previous proposals for the construction of commutating devices in miniature motors will first be described with reference to Figures 2 to 6.

In conventional miniature motors, a commutator device

as shown in Figure 2 is commonly used. Brushes 1 connected to a supply (not known) carry electrical current to a commutator 3 having commutator segments 4. Each brush 1, usually called a "flat brush", has at the tip thereof fork-shaped brush shoes 2. The commutator segments 4 are separated from each other by separating grooves 5 formed in the axial direction of the motor. Each brush shoe 2 makes sliding contact with the segment 4 along with the rotation of the motor, and as the motor rotates, the following undesirable problems are caused as the brush shoe 2 passes over the separating groove 5.

1) Since the supply of current to the rotor winding is instantaneously interrupted, it is difficult to ensure a constant supply of current to the rotor winding.

2) The instantaneous current interruption causes electrical sparks between the brush shoe 2 and the segment 4, accelerating the wear of both the brush shoe 2 and the segment 4. This leads to reduced service life of the motor.

3) The instantaneous current interruption causes electrical noise, adversely affecting other adjoining electrical equipment.

In the motor shown in Figure 2, blackened foul matter 7 (normally originating from insulating material in the motor) having relatively high electrical resistance tends to build up on the edges of a brush contact zone 6 of the segment 4, that is, the portion of the segment 4 at which the segment 4 makes contact wit the brush shoe 2.

Formation of the blackened foul matter 7 is substantially inevitable because its generation is largely attributed to sliding contact and sparks referred to above.

As the brush 1 shown in Figure 2 is a so-called "flat brush", the pushing force that the shoe 2 exerts on the segment 4 is relatively low, and the area covered by the foul matter 7 tends to extend away from the edges of the segments 4, as indicated at a in Figure 3. As a consequence, the interruption of current to the rotor winding is extended, making the current supply to the rotor winding increasingly unstable.

To meet the above problems, commutator devices for miniature motors of the kind shown in Figures 4 to 6 have been proposed.

In the example shown in Figure 4, the commutator 3 has been adapted with the aim of maintaining a stable current supply to the rotor winding by using a brush 1 of a so-called "cross brush" type. In the example shown in Figure 5, the brush 1 is of the same type as that shown in Figure 2, but the commutator 3 is formed into a so-called "skew" type to stabilize the current supply to the rotor winding. In the example shown in Figure 6, the brush 1 is of the same type as that shown in Figure 2, but the commutator 3 is formed into a so-called "crank type" to stabilize the current supply to the rotor winding.

According to our study, however, in each of these examples the following problems appear:

(1) The brushes 1 used in the examples shown in Figures 4 through 6 are all of the flat type in which the

surface of the brush shoe 2 makes sliding contact with the surface of the segment 4. This tends to increase the area a of blackened foul matter illustrated in Figure 3. Consequently, each of the "cross" angle θ_1 (shown in Figure 4C) of the brush 1 in the example shown in Figure 4, the "skew" angle θ_2 (shown in Figure 5C) of the commutator 3 in the example shown in Figure 5, and the "crank" angle θ_3 (shown in Figure 6C) of the commutator 3 in the example shown in Figure 6 must be set at a relatively large value. For good performance and stability however, and to ensure effective commutation, the "cross" angle θ_1, and "skew" angle θ_2 and the "crank" angle θ_3 should be set at the smallest possible value.

(2) Although a certain degree of wear of brushes cannot be avoided in electric motors of this type, brush wear remains an important element in design which is relevant in determining the life of the motor. However, the brushes 1 used in the examples of Figures 4 to 6 are all of the flat type in which contact is maintained between the surfaces of the brush shoe 2 and the segment 4. For this reason, a relatively short brush life is a disadvantage common to all the examples shown in Figures 4 to 6.

(3) The brush 1 of the "cross" type in the example shown in Figure 4 and the commutator 3 of the "skew" type in the example shown in Figure 5 are complex in construction, and need a high level of manufacturing accuracy in maintaining the above-mentioned angles θ constant. This makes volume production difficult, leading

to high costs.

In the embodiment of the invention shown in Figure 1, a brush 1 has brush shoes 2 formed into a V-shape in cross-section; the two legs each of the inverted V-shaped brush shoes 2 make sliding contact with segments 4. The commutator 3 is of a so-called crank type so that separating grooves 5 provided between the segments 4 are formed into a crank shape having a "crank" angle θ (shown in Figure 1C). The length of the shaped portion of the brush 1; ie, the brush shoe 2 is adapted to make contact with the commutator over a sufficiently wider angle than the crank angle θ so that the brush shoe 2 can make contact simultaneously with two succession segments 4.

Sliding contact between the commutator 3 and the brush 1 in this invention is effected at both ends of the inverted V-shaped legs of the brush shoe 2. Further, the flexural strength of the brush shoe 2 is increased because of the V-shaped cross-section thereof. Each of these factors increases brush pressure per unit area, and results in removal of the blackened foul matter 7 described above with reference to Figure 3 by the rubbing action of both ends of the inverted V-shaped legs of the brush shoe 2.

As a result, the blackened foul matter producing area a can be reduced, making it possible to adopt a relatively small crank angle θ in each separating groove 5. The blackened foul matter 7 can be removed more efficiently by a smaller crank angle than the crank angle θ_3 shown in Figure 6C. This in turn makes it possible to

θ_3 shown in Figure 6C. This in turn makes it possible to substantially improve the commutating effect. In addition, the length of the inverted V-shaped brush shoe section 2 can be reduced due to a small crank angle θ, making if favourable to reduce the size of the motor.

Since the brush shoe 2 is formed into a V-shape and makes sliding contact with the segment 4 at both ends of the inverted V-shaped legs thereof, the height (shown by arrow t in Figure 1C) of the portion at which the brush shoe 2 makes contact with the segment 4 is increased. This gives the brush an increased allowance for wear, leading to a substantial increase in the service life of the brush 1.

The brushes 1 and commutator segments 4 are typically formed from electrically conductive metal strips. This enables a straightforward pressing or stamping operation to be employed to form the brush shoe 2 into a V-shape and to form the segment 4 of the commutator 3 into a crank shape with high accuracy and ease, thus facilitating mass production.

In the embodiment shown, the brush 1 has three fork-shaped brush shoes 2 each having the inverted V-shaped cross-section. The brush, however, may have one brush shoe or a plurality of brush shoes, taking into consideration the resiliency of the brush. If the brush is constructed by a plurality of fork-shaped springs, even the contact of the brush shoe with the commutator at the vertex of the V-shape thereof gives a high pushing force per unit area, bringing the same effect as described

As described above, this invention makes it possible to increase pushing force per unit area between the commutator and the brush, thus preventing or at least inhibiting the obstructive formation of blackened foul matter of the kind shown in Figure 3. This enables electrical contact to be stabilized. The V-shaped brush gives the brush shoe an increased allowance for wear, and can be mass-produced at high accuracy by a stamping operation. As a result, the commutating effect can be stabilized and improved, and electrical sparks can be substantially reduced or eliminated. This results in an extended service life of the brush, and accordingly in an increased life of the motor. Being largely free of electrical sparks, motors including devices of this invention do not adversely affect other pieces of electrical equipment.

CLAIMS

1. A commutator device for electric motors comprising a commutator and electrically conductive brushes for making sliding electrical contact therewith, the commutator having a plurality of commutator segments separated by crank shaped grooves, and each brush having at least one brush shoe extending in a plane substantially perpendicular to the commutator axis for tangential engagement with the commutator segments, at least a portion of said at least one brush shoe having a cross-section shaped to define at least one linear edge extending along the shoe in said plane for engagement with the commutator.

2. A commutator device according to Claim 1 wherein said portion of said at least one brush shoe has a V-shaped cross-section.

3. A commutator device according to Claim 2 wherein said at least one brush shoe is oriented such that linear edges at the distal ends of the legs of its cross-section engage the commutator surface.

4. A commutator device according to Claim 2 wherein said at least one brush shoe is oriented such that the linear edge at the junction of the legs of its cross-section engages the commutator surface.

5. A commutator device according to any preceding claim wherein each brush has a plurality of elongate brush shoes extending from the body of the brush to define a plurality of linear edges substantially parallel to one another.

6. A commutator device for electric motors substantially

as described herein with reference to Figures 1A, 1B and 1C of the accompanying drawings.

7. An electric motor including a commutator device according to any preceding Claim.

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